US006483397B2

(12) **United States Patent**
Catoiu

(10) **Patent No.: US 6,483,397 B2**
(45) **Date of Patent: Nov. 19, 2002**

(54) **TANDEM SIX PORT 3:1 DIVIDER COMBINER**

(75) Inventor: **Miron Catoiu**, Kitchener (CA)

(73) Assignee: **Raytheon Company**, Lexington, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/834,570**

(22) Filed: **Apr. 12, 2001**

(65) **Prior Publication Data**

US 2002/0149441 A1 Oct. 17, 2002

Related U.S. Application Data

(60) Provisional application No. 60/253,607, filed on Nov. 27, 2000.

(51) **Int. Cl.**[7] **H01P 5/18**

(52) **U.S. Cl.** **333/116**; 333/117

(58) **Field of Search** 333/26, 25, 116, 333/117, 33

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,846,721 A	*	11/1974	Fritz et al.	333/26
5,003,622 A	*	3/1991	Ma et al.	333/26
5,006,821 A	*	4/1991	Tam	333/116
5,446,425 A	*	8/1995	Banda	333/116
5,634,208 A	*	5/1997	Nishikawa et al.	455/327
6,278,340 B1	*	8/2001	Liu	333/26

OTHER PUBLICATIONS

"Multi–port Lattice–type Hybrid Networks", by Takaji Kuroda, Takeshi Usui, and Kazuo Yano. IEEE–GMTT International Microwave Symposium (May 17, 1971), pp. 10–11.

"Planar, Multiport, Quadrature–Like Power Dividers/Combiners", by A. A. M. Saleh. IEEE Trans on MTT, vol. MTT–28 (Jun. 1980) pp. 483–486.

"An N–Way Hybrid Power Divider", E. J. Wilkinson, IRE Trans on MTT, vol. MTT–8 (Jan. 1960) pp. 116–118.

"A New N–Way Power Divider/Combiner Suitable For High Power Applications", U.H. Gysel. 1975 MTTS International Microwave Symposium, pp. 116–118.

(List continued on next page.)

Primary Examiner—Robert Pascal
Assistant Examiner—Dean Takaoka
(74) *Attorney, Agent, or Firm*—Daly, Crowley & Mofford, LLP

(57) **ABSTRACT**

A six port 3:1 power divider and combiner. The inventive divider/combiner includes first, second and third weakly coupled transmission lines. The first transmission line provides first and second ports at first and second ends thereof, respectively. The second transmission line provides third and fourth ports at first and second ends thereof, respectively and the third transmission line provides fifth and sixth ports at first and second ends thereof, respectively. In the illustrative embodiment, the first, second and third transmission lines are coupled to provide equal outputs at said second, fourth and sixth ports in response to an application of a signal at the first port. The first second and third conductors may be implemented with coaxial, stripline or microstrip type transmission lines. The looser coupling is very beneficial, especially in microstrip, to obtain high power capability and a manufacturable circuit. In an illustrative 3:1 divider/combiner implementation, the coupling arrangement provides a voltage coupling coefficient x equal to 0.325057. Consequently, the first, second and third coupling lines have a relative coupling value of approximately −10 decibels. In the best mode, the first, second and third coupling lines have a relative coupling value of −9.76 decibels.

52 Claims, 2 Drawing Sheets